

REH

RE 1/30/5

RED 2/2

N 67 40192

Some interesting

conclusions on pg 18-20.

NASA CR 89597

S. V.



DEPARTMENT OF ECONOMICS
WASHINGTON UNIVERSITY
ST. LOUIS, MISSOURI

COMPETITION IN HIGH TECHNOLOGY
GOVERNMENT MARKETS

By
Murray L. Weidenbaum
Professor of Economics
Washington University

Working Paper 6713
November 1967

This study was supported by National
Aeronautics and Space Administration
Grant NsG-342 to Washington University,
St. Louis, Missouri, 63130.

(A paper to be presented at the
American Marketing Association
National Meeting, Washington,
D. C., December 27, 1967)

COMPETITION IN HIGH TECHNOLOGY

GOVERNMENT MARKETS

By Murray L. Weidenbaum

ABSTRACT: This study examines the nature of competition in high technology government markets, notably the Department of Defense and the National Aeronautics and Space Administration. In the absence of comprehensive information on individual competitions for government contracts, turnover data and concentration ratios are developed as a guide to the extent to which relatively few firms dominate this market area. Analyses of the size distribution of leading government contractors also help to illuminate the nature of the competitors for government contracts. On balance, statements so frequently made concerning the large degree of concentration and monopoly in government procurement are not supported by the data.

ABOUT THE AUTHOR: Murray L. Weidenbaum is Chairman of the Department of Economics and Director of the NASA Economic Research Program at Washington University, St. Louis, Missouri. He has previously served as the Corporate Economist for the Boeing Company and Executive Secretary of the President's Committee on the Economic Impact of Defense and Disarmament.

Mr. Weidenbaum has authored various studies on defense and space marketing, including The Military Market in the United States, published by the American Marketing Association in 1963. He received his Ph. D. from Princeton University. This research was supported by NASA Grant NsG-342 to Washington University.

COMPETITION IN HIGH TECHNOLOGY GOVERNMENT MARKETS¹

It has become commonplace to point to the concentration of government contracts for military, space, and related high technology products in a relatively few companies and to bemoan the lack of competition in this large and growing market area. The purpose of this study is to examine the available information so as to illuminate the nature of the competition within these high technology government markets and to see the extent to which they actually are dominated by a relatively few large firms.

The results in the aggregate are not clear cut. Medium size and fairly large firms obtain the largest market shares, rather than either the corporate giants or the really small firms. The evidence also points to considerable concentration in the market as a whole, but to substantial competition in many parts of it.

INTRODUCTION

The government markets for high technology products in the United States comprise primarily the expenditures by the Department of Defense (DOD) and the National Aeronautics and Space Administration (NASA) for research and development, production of weapon and space systems and equipment, and construction projects. These are the two agencies that account for the great bulk of government sponsorship of science and technology and also purchase on a large scale the products and systems that result from the R & D efforts. Included but not emphasized in this study are procurements of items common to both the military-space and the civilian markets, such as medical supplies. Outlays for personnel, civilian public works, and transfer payments are excluded.

¹The author is indebted to Stephen Seninger, who served as his research assistant on this study.

Because these high technology markets are so completely subject to the changing needs of the governmental customer, relationships between buyers and sellers differ from those in the commercial sector of the economy. By the selection of contractors, the government can control entry and exit, can greatly affect the growth of the firms involved, and can impose its ways of doing business on the companies participating.²

Contracts are let as a result of negotiation with a group of suppliers chosen by the buyers. The governmental buyers normally request proposals from among the various firms who are in a position to undertake the magnitude of R & D and production required. However keen competition among the prospective suppliers may become, it will relate to their technological capability and not simply to price. The nature of the buyers' demands may be far less a direct function of their budgets than of the products or systems available through technological advance. More fundamentally, the intensity of the governmental demands may result from the advances in military and space technology achieved by other nations.

The great bulk of the work is performed by corporations oriented to public requirements rather than market demands. These government-oriented corporations are companies or fairly autonomous divisions of large, diversified corporations whose dominant customers are the defense and space agencies of the Federal Government. The close, continuing relationship between the government and these

²Cf. Merton J. Peck and Frederic M. Scherer, The Weapons Acquisition Process: An Economic Analysis, Boston, Harvard University Graduate School of Business Administration, 1962; William L. Baldwin, The Structure of the Defense Market 1955-1964, Durham, Duke University Press, 1967.

corporations is more than regulation by Federal agencies or selling in markets where the government is a major determinant of price, as in the case of public utilities, agriculture, or mining. Rather, it is the intertwining of the public and private sectors so that it is difficult to identify when specific entrepreneurial or management functions in a given organization are being performed primarily by government agents or by private individuals on business payrolls. This mixing of public and private roles in internal business decisions of government contractors relates to such basic activities as the initiative for new undertaking and risk-bearing and ranges from product development decisions to the remuneration of management.

THE SELLERS

As is generally known, a relatively limited number of companies receive the bulk of the defense and space contract awards. In the fiscal year 1966, the 100 companies obtaining the largest dollar volume of military prime contracts accounted for 64 percent of the Department of Defense total. In the case of NASA, the top 100 companies received 91 percent of the total contracts awarded during the year.³

However, any adequate analysis of competition in these high technology government markets must examine both the nature of the sellers and the products being purchased by the buyers. As an indication of the limited usefulness of these initial aggregate comparisons, the 64 percent share of defense contracts obtained by the 100 leading contractors in 1966 is substantially below the range

³Department of Defense, 100 Companies and Their Subsidiary Corporations Listed According to Net Value of Military Prime Contract Awards, Fiscal Year 1966; National Aeronautics and Space Administration, Annual Procurement Report, Fiscal Year 1966. For a detailed evaluation of such comparisons, see Baldwin, op. cit., Chapter II.

of 72-74 percent experienced during 1960-64, prior to the expansion of Vietnam requirements. The decline in relative importance was experienced entirely by the top 25, whose share declined from 52.9 percent in 1964 to 43.0 percent in 1966 (see Table 1).

This shift reflected no substantial change in competitive forces, but rather the shift in the buyers' requirements and hence the proportionally smaller role of the aerospace giants in procurement dominated by the conventional product requirements of limited war. This development also demonstrated that the barriers to company entry or growth in government markets are relatively low; government provision of fixed capital in the form of loan of plant and equipment and working capital in the form of progress payments undoubtedly is an important explanatory factor.

Table 1

CONCENTRATION TRENDS IN MILITARY PROCUREMENT, FISCAL YEARS 1960-66
Shares Received By Major DOD Contractors

<u>Company Rank</u>	<u>1960</u>	<u>1961</u>	<u>1962</u>	<u>1963</u>	<u>1964</u>	<u>1965</u>	<u>1966</u>
1st	6.0%	6.5%	5.6%	5.9%	5.8%	7.1%	4.6%
2nd	5.1	5.2	4.7	5.2	5.4	4.9	3.5
3rd	4.8	5.2	4.4	4.1	4.6	3.5	3.4
4th	4.6	4.1	4.0	4.0	4.1	3.4	3.4
5th	4.3	3.8	3.8	4.0	3.9	3.1	2.7
1 - 5	24.8	24.8	22.5	23.2	23.8	22.0	17.6
6 - 10	11.3	11.8	11.1	10.9	12.0	10.2	9.0
11 - 25	17.4	18.2	17.2	17.8	17.1	16.0	16.4
1 - 25	53.5	54.8	50.8	51.9	52.9	48.2	43.0
26 - 50	11.3	11.0	12.6	13.7	12.9	13.0	12.1
51 - 75	5.4	5.5	6.0	5.5	5.1	5.2	5.4
76 - 100	3.2	2.9	2.9	2.8	2.5	2.5	3.3
1 - 100	73.4	74.2	72.3	73.9	73.4	68.9	63.8
All other	26.6	25.8	27.7	26.1	26.6	31.1	36.2
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Department of Defense, 100 Companies and Their Subsidiary Corporations Listed According to Net Value of Military Prime Contract Awards, Fiscal Year 1966.

Although this analysis focuses on military contractors, it needs to be noted that the correspondence between the major DOD and NASA contractors is quite high. For example, 16 of the top 25 NASA suppliers in fiscal 1966 were also among the top 25 DOD contractors; the other 9 all made the top 100 DOD list for the year.

An analysis of the size distribution of the top 100 DOD contractors provides another dimension to the structure of government markets. It can be seen (Table 2) that the giants do not dominate, contrary to much of the writing on the so-called military-industrial complex. Rather, the medium size corporations receive the largest share of the orders for high technology government products. The 27 corporations with assets of \$1 billion or over received only 17 percent of the DOD contracts in 1965, while the 30 companies with assets in the \$250-999 million range received 39 percent of the contracts. Relatively small companies did proportionally poorer; the 37 companies with assets below \$250 million accounted for only 11 percent of the total.

Table 2

SIZE DISTRIBUTION OF MAJOR DEFENSE CONTRACTORS, FISCAL YEAR 1965

<u>Asset Size^a</u>	<u>No. of Companies</u>	<u>Share of Defense Contractors</u>
\$5 billion & over	7	6.4%
\$1 - 5 billion	20	11.0
\$500 - 999 million	14	26.0
\$250 - 499 million	16	12.7
\$100 - 250 million	15	6.2
Under \$100 million	22	5.1
Non profit institutions	6	1.5
Total	100	68.9%

^aExcludes assets provided by the Federal Government

Source: Department of Defense; Fortune, July, 1966, pp. 232-248; and Moody's Industrials, 1966.

Another dimension of the structure of the government markets for high technology products relates to the extent of dependence on government work among the major contractors, that is, to the nature of the Government-oriented corporations. Again, the data indicate that the firms most heavily dependent on military orders are the medium-sized companies rather than the giants of American industry (see Table 3). Of the top 100 defense contractors in 1965, for the seven with assets of \$5 billion or over, defense contracts equalled less than 10 percent of their sales. For those 20 firms with assets in the \$1-5 billion range, defense orders equalled less than 25 percent of sales. In contrast, 21 out of the 44 firms with assets of \$100-999 million obtained defense contracts exceeding 25 percent of their sales; in the case of 10 of these firms these government orders exceeded half of their sales volume.

Table 3

IMPORTANCE OF DEFENSE ORDERS TO TOP DOD CONTRACTORS,
RANKED BY ASSET SIZE, 1965^a

<u>Asset Size</u>	<u>Defense Contracts as Percent of Sales^b</u>				
	<u>75-100%</u>	<u>50-74%</u>	<u>25-49%</u>	<u>10-25%</u>	<u>Less than 10%</u>
\$5 billion and over	0	0	0	0	7
\$1-4.9 billion	0	0	0	5	15
\$500-999 million	2	0	5	6	1
\$250-499 million	1	3	2	5	4
\$100-249 million	2	2	4	6	1
Less than \$100 million	4	5	6	1	0

^a Includes all business firms listed in DOD report on top 100 contractors, but excludes universities and non-profit institutions.

^b Contracts cover government fiscal year 1965; sales cover company fiscal year ending in 1965.

Source: Department of Defense, 100 Companies and Their Subsidiary Corporations Listed According to Net Value of Military Prime Contract Awards, Fiscal Year 1965; Fortune, July 15, 1966; Moody's Industrial Manual, June 1966; Standard & Poor's, 1966-67.

Also, the majority of the smaller firms, those with assets under \$100 million received defense contracts exceeding 50 percent of their sales. This experience is hardly typical of the thousands of smaller businesses participating in government markets; rather, it reflects the nature of the sample, which is limited to firms receiving the largest absolute amounts of defense contracts.

THE NATURE OF COMPETITION

During the past decade, over 80 percent of the government procurement of high technology products and systems has been made through negotiated rather than sealed-bid purchasing; hence, price is not determined by the interplay of relatively impersonal market forces.

The government agencies involved maintain that negotiation does not signify lack of competition. The Army's Deputy Chief of Staff for Logistics has stated that, "The fact is that the great majority of negotiated procurements are made on a highly competitive basis!"⁴ He cited a case where 189 potential producers of a piece of equipment were solicited and keen price competition ensued.

The Armed Services Procurement Act, under which both DOD and NASA operate, requires that awards be made to the bidder whose bid, price and other factors considered, is most advantageous to the Government. In practice, there is a variety of other factors on which rival potential suppliers compete. The previous

⁴U. S. House of Representatives, Committee on Appropriations, Hearings on Department of Defense Appropriations for 1963, Part 4, Washington: U. S. Government Printing Office, 1962, p. 19. "Comments of Department of Defense officials, industry executives, the trade press, and knowledgeable critics indicate an overwhelming, perhaps unanimous agreement, that competition in the sense of interfirm rivalry is intense in the defense market." Baldwin, op. cit., p. 117.

performance of the company may be an extremely useful indicator of its effectiveness on a future contract. The present availability of skilled manpower and other resources also may be an important determinant of its future performance. The emphasis on non-cost factors, particularly in awarding R & D contracts, has been pointed out on numerous occasions.

A Director of Procurement of the Air Research and Development Command stated to a Congressional committee that, in contracting for research, "The most compelling factor is the technical competence of the individual or firm under consideration ... The financial responsibility, facilities available to perform the work, ability to obtain security clearance, and performance experience on previous contracts are also major factors considered."⁵

On large production contracts, cost may become a more dominant element. On all types of large system contracts, the influence of cost is indirect as well as direct. Throughout the production period, the item is competing for funds in the budget against alternative systems that may fulfill similar missions (for example, strategic bombers vs. ICBM's, both of which provide nuclear offensive capability). With the current emphasis in military planning on the relative cost-effectiveness of alternative weapon systems, the importance of the cost factor is tending to increase.

Frederic Scherer cites the cancellation of the Skybolt missile as an example of the adverse results of a contractor permitting costs to rise excessively. He contends that the immediate or potential competition of substitute systems which

⁵U. S. Senate, Select Committee on Small Business, The Role of Small Business in Defense Missile Procurement -- 1958, Hearings before a Subcommittee, April 29 - May 1, 1958, Washington: U. S. Government Printing Office, 1958, p. 59.

threaten a firm with program cancellation or reduction may affect the firm's behavior in many ways. Factors specifically affected could include the propensity to innovate, time-quality-cost tradeoff decisions, efforts to achieve efficiency, talent allocation decisions, and morale.⁶

However, Hall and Johnson use the term "rivalry" in place of competition in discussing the military market, pointing out that usually when an economist uses the term "competition", he means rivalry with price as the weapon. Almost invariably in military contracting, competition means rivalry between potential contractors about any variable, but most often technical performance.⁷ Also, Peck and Scherer state, "Yet however pervasive this competition it is not the price competition that occurs in a market situation."⁸

THE MEASUREMENT OF COMPETITION

It is helpful to develop some quantitative measures of the degree of competition or rivalry in government markets for high technology products. Using aggregate data, in the fiscal year 1966 the Department of Defense and NASA categorized their procurements as follows, indicating that the bulk of NASA procurement and one-half of DOD awards were competitively let:

⁶Frederic M. Scherer, The Weapons Acquisition Process: Economic Incentives, Boston, Harvard University Graduate School of Business Administration, 1964, pp. 22, 53.

⁷George R. Hall and Robert E. Johnson, A Review of Air Force Procurement, 1962-1964, RAND Corporation Memorandum RM-4500-Pr, May 1965, p. 47.

⁸Peck and Scherer, op. cit., p. 57.

	<u>DOD</u>	<u>NASA</u>
<u>Types of Competition</u>	<u>Percent of Total</u>	
Noncompetitive:		
Follow-on after price or design competition	20.0	9.1
Other one-source solicitation	30.0	25.0
Competitive:		
Formally advertised	14.2	2.7
Small business and labor surplus area set-asides	4.7	63.1
Open market purchases of \$2,500 or less	4.6	
Other price competition	20.9	
Design or technical competition	5.6	
Total	<u>100.0</u>	<u>100.0</u>

However, the Pentagon's statistics on the proportion of contracts which is awarded on the basis of competition have been criticized on several occasions. Recently, the Comptroller General has chided the Department of Defense for classifying as competitive all awards under \$2,500 and contracts for which only one bid was received, although requests for proposals had been sent out to several firms.⁹ Unfortunately, comprehensive statistics on individual competitions, including information on the number of companies that actually responded with bids, are not available.

Turnover Among Government Suppliers

One method of indirectly analyzing the degree of competition is to examine the turnover among the dominant firms in a given market area. Table 4 summarizes the turnover among defense contractors during the past decade. Viewed in isolation, it would appear that the entrenchment of the dominant firms is striking; 21 of the

⁹U. S. Congress, Joint Economic Committee, Economy in Government, Part 1, Washington: U. S. Government Printing Office, 1967, p. 9, Cf. also Hall and Johnson, op. cit., p. 88.

top 25 contractors in 1966 were also in the top 25 in 1957. However, it may be interesting to compare this result with the turnover during the same period among all American industrial corporations, ranked by total sales. It turns out that 21 of the top 25 industrial firms in 1966 also were on the list of the top 25 in 1967. The exact correspondence to the defense situation may be quite coincidental. However, the comparison indicates that market concentration is not unique to government purchasing.

The relatively great stability of the dominant firms in the military market, which are mainly the large aerospace and electronics companies, results in good measure from the substantial barriers to both entry into and exit from the market for major weapon systems. The entry barriers mainly take the form of scientific development capabilities required to design and produce modern weapon systems. The exit barriers, in contrast, can be inferred from the many unsuccessful attempts these companies have experienced in penetrating commercial markets.

In contrast, considerable mobility is evidenced in the ranking of the firms which have large, but not so marked, shares of defense business. Of the next

Table 4

TURNOVER AMONG MAJOR DEFENSE CONTRACTORS
1957 (calendar year) to 1966 (Fiscal Year)

Top 100 Contractors FY 1966	Ranking in Calendar Year 1957					Total
	1-25	26-50	51-75	76-100	Below 100	
1 - 25	21	2	0	0	2	25
26 - 50	3	8	5	4	5	25
51 - 75	0	4	2	2	17	25
76 - 100	0	2	2	3	18	25
Total	24	16	9	9	42	100

Source: Department of Defense, 100 Companies and Their Subsidiary Corporations Listed According to Net Value of Military Prime Contract Awards, Fiscal Year 1966 and Calendar Year 1957.

75 firms, 42 or 56 percent were not on the list of the top 100 defense contractors in 1957. Between 1965 and 1966 alone, 28 percent of the firms on the top 100 list were replaced. This shift, which occurred primarily among non-aerospace firms, also reflects the changing product mix of government procurement and, hence, the influence of technology. A decade ago, the large missile programs brought many firms into the military market as suppliers of mechanical ground support equipment, fabricators of silos, and builders of tracking stations. The decline in missile procurement and the rise of ordnance required a different set of technical capabilities and a new variety of industries.

Concentration Ratios in Government Markets

Another indirect method of estimating the degree of competition in high technology government markets is to examine the degree of concentration of sellers in the major product categories. Such statistics do not reveal the number of competitors or the severity of competition for individual contracts. At the least, however, the data indicate the extent to which different firms are active in the various segments of the market.

There has been considerable discussion in the literature concerning the validity and usefulness of concentration ratios as measures of industrial concentration and competition. Morris Adelman states that "The concentration ratio is a fairly crude approximation but, so far, it is the only thing we have which fits the requirements of economic theory that it have some relevance to market behavior."¹⁰ Adelman concludes that, "as a general statistical matter, the greater the concentration

¹⁰Economic Concentration, Hearings before the Subcommittee on Antitrust and Monopoly of the Committee on the Judiciary, U. S. Senate, Part 1, Washington: U. S. Government Printing Office, 1964, p. 231.

the lower the odds in favor of competitive behavior". He points out that more refined measures have been proposed, but that they have not as yet proved useful.¹¹

The concentration ratio takes account of both the number and size distribution of firms in a market, yet presents the results in a form simple enough that it is easy to interpret and to make comparisons with other markets. To compute a concentration ratio it is necessary to rank firms in order of size, starting from the largest in the industry. Size is usually measured in terms of either sales or employment. Then, starting from the top of the list, the percentages of the industry or market are then cumulated. Published statistics usually present cumulative concentration ratios for the largest four, largest eight, and sometimes the largest twenty firms in an industry.

The concentration ratio for a monopoly would, of course, be 100 percent. The ratio for the largest four firms in a competitive industry would be relatively small, perhaps five or ten percent. The highly concentrated (oligopolistic) . markets would show concentration ratios somewhere in between these two extremes.¹² Table 5 is an attempt to develop concentration ratios for an important segment of the high technology government market, Air Force procurements in the fiscal year 1966. This market segment has been selected because of the availability of data. It can be seen that the implicit degree of competition varies substantially among the product categories. Four firms account for 86 percent of the engine contracts (by value) and for only 7 percent of miscellaneous supplies and equipment.

¹¹Ibid., pp. 230-231.

¹²Cf. Richard Caves, American Industry: Structure, Conduct, Performance, Second edition, Englewood Cliffs, New Jersey: Prentice-Hall, 1967, p. 8.

Table 5

MARKET CONCENTRATION IN U. S. AIR FORCE PROCUREMENT, FISCAL YEAR 1966

<u>Market Category</u>	<u>Size (Millions)</u>	<u>Percent of Contracts</u>		
		<u>Top 4 Firms</u>	<u>Top 8 Firms</u>	<u>Companies with over 1% of contracts</u>
Containers	\$ 7.2	88.2	94.1 ¹	94.1
Aircraft engines	2,184.9	86.5	92.4 ¹	92.4
Transportation equipment	9.1	83.0	93.6	96.6
Combat vehicles	590.3	65.4	78.7	81.1
Other fuels and lubes	54.3	64.3	71.1	84.0
Airframes and spares	4,760.2	55.8	78.6	91.2
Non-combat vehicles	999.2	55.5	68.5	73.9
Photographic supplies and equipment	164.8	52.8	68.0	77.1
Construction equipment	217.1	43.6	65.1	76.3
Petroleum	1,279.4	38.3	54.3	69.9
Ships	1,436.2	37.5	53.5	63.5
Missile and space systems	4,394.8	35.4	55.6	82.7
Materials handling equipment	105.3	35.2	46.6	64.2
Construction	1,856.1	34.0	36.2 ²	36.2
Weapons	523.5	31.2	39.0	51.2
Other aircraft parts	1,053.6	23.7	37.4	60.1
Building supplies	411.7	23.4	38.0	70.1
Electronics equipment	3,995.0	22.8	35.0	49.7
Ammunition	2,899.4	20.7	31.1	57.8
Production equipment	179.5	20.6	34.4	60.2
Services	3,040.9	17.6	24.5	30.4
Medical and dental equipment	215.2	17.2	27.3	48.3
Textiles and clothing	1,286.4	13.2	19.6	23.3
Subsistence	1,102.4	8.0	10.3 ²	10.3
All other supplies and equipment	1,463.6	7.5	12.0	13.0

¹Top seven firms

²Top six firms

Source: Computed from data supplied by Data Services Center, Comptroller,
Headquarters U. S. Air Force.

No doubt a finer breakdown (fighters, bombers, transports, trainers, etc. in the aircraft category, for example) would show a greater degree of concentration. The level of product aggregation used here is based entirely on the limited availability of data.

Some further analysis of the raw data in Table 5 may be helpful in indicating the extent of concentration in Air Force purchasing. It would seem desirable to eliminate the categories which are so small that it is unlikely that they constituted meaningful areas of competition. For example, even though 4 firms accounted for over 88 percent of Air Force contracts for containers in the fiscal year 1966, total awards for containers only came to \$7.2 million. Hence, it may be more fruitful to concentrate on the 17 product categories in which total awards for the year were \$250 million or more.

It is necessary of course to utilize some standards for measuring concentration. Joe Bain has suggested that high seller concentration occurs when the largest eight firms control 70 percent or more of the sales of the industry.¹³ However, Kaysen and Turner provide less stringent standards. They view relatively concentrated industries or "oligopolies" as those where the largest eight firms make 33 percent or more of the shipments. They group oligopolies into two categories. Type I, heavily concentrated industries, exist where the largest eight firms make at least 50 percent of the industry's shipments and the largest twenty firms make at least 75 percent. In Type II oligopolies (moderately concentrated industries), the first eight firms make 33 percent or more of the shipments, but less than 50 percent.¹⁴

¹³Joe S. Bain, Barriers to New Competition, Cambridge, Harvard University Press, 1956, pp. 195-196.

¹⁴Carl Kaysen and Donald F. Turner, Antitrust Policy: An Economic and Legal Analysis, Cambridge, Harvard University Press, 1959, p. 30.

Of the 17 major Air Force product categories, in only three cases did eight companies account for 70 percent or more of the "market" (using the Bain criterion of high concentration) -- aircraft engines, combat vehicles, and airframes and spares. Large market areas which then, would be considered areas of "moderate to low" concentration by the Bain criterion include such important cases as missile and space systems, weapons, ammunition, electronics equipment, construction, and noncombat vehicles. Some of these market categories apparently not dominated by a few firms are ones characterized by extremely advanced technology, notable missiles, space, and electronics.

However, if we use the Kaysen-Turner standards of market concentration, a somewhat less sanguine picture emerges of competition in the high technology government market under study. Only five "unconcentrated" markets show up -- ammunition, services, textiles and clothing, subsistence, and all other supplies and equipment -- and some of these are rather broad and heterogeneous product groupings. Type I oligopolies -- the more heavily concentrated market areas -- include the three cases that meet Bain's criterion plus missile and space systems. Eight other market categories show up as category II oligopolies (see Table 6).

More aggregate comparisons also can be made. However, no clear picture emerges when U.S.A.F. procurement in 1966 is compared with the American industrial market structure as a whole in 1958, the latest period for which comparable data are available. Weighted aggregated four-firm concentration ratios are compared below:

	Percent of Value of Shipments by Category of Concentration Ratios			
	<u>75-100</u>	<u>50-75</u>	<u>0-50</u>	<u>Total</u>
U. S. manufacturing, 1958 ¹⁵	7.9%	14.7%	77.4%	100.0%
U.S.A.F. procurement, 1966	6.4	19.2	74.4	100.0

¹⁵Economic Concentration, op. cit., Part 1, p. 3.

In the category of greatest concentration, Air Force procurement is slightly less concentrated than manufacturing as a whole. The above comparison indicates that 7.9 percent of total manufacturing shipments in 1958 were from industries in which 4 firms accounted for 75 percent or more of the value of shipments, while only 6.4 percent of the U. S. Air Force contracts awarded in fiscal year 1966 were in product categories where 4 firms accounted for 75 percent or more of the contracts. However, in the medium range of concentration, where four firms account for 50 to 75 percent of the market, the Air Force procurements are shown to be more highly concentrated; 19.2% of the U.S.A.F. contracts were in this category while only 14.7% of total manufacturing were.

Table 6

MARKET CHARACTER OF AIR FORCE PROCUREMENT

<u>Heavily Concentrated</u>	<u>Moderately Concentrated</u>	<u>Relatively Unconcentrated</u>
Aircraft Engines	Non-combat Vehicles	Subsistence
Combat Vehicles	Ships	Ammunition
Airframes & Spares	Petroleum	Services
Missile and Space Systems	Construction	Textiles and Clothing
	Weapons	All other Supplies and Equipment
	Other Aircraft Parts	
	Building Supplies	
	Electronics Equipment	

Source: Table 5 and Kaysen and Turner, op. cit.

More of the total manufacturing market was in the relatively unconcentrated category (concentration ratios of less than 50 percent) -- 77.4% compared to 74.4% of the Air Force. Of perhaps greater relevance is the fact that the vast bulk of both manufacturing output as a whole and Air Force requirements in particular were purchased from relatively unconcentrated industries, indicating substantial amounts of at least potential competition. The comparisons are hardly conclusive. More comprehensive data on high technology government procurements would be needed and over longer time periods before any conclusions on the extent of competition in this market area could be reached with confidence.

SUMMARY AND CONCLUSIONS

1. The high technology government markets stand at the intersection between the public and private sectors in the American economy. This unique market area (the purchases by the Department of Defense and NASA) has several distinguishing characteristics: it is in a sense monopsonistic; ^(one buyer & seller) price often is not the controlling determinant of sales; technical capability is a major competitive requirement; technological change leads to rapid obsolescence; production occurs after the sale and is not for inventory; and the bulk of the work is performed by corporations oriented to public requirements rather than market demands.

2. A relatively limited number of companies receive most of the defense and space contract awards. In the fiscal year 1966, 100 companies accounted for 64 percent of the defense contracts awarded and 91 percent of the NASA contracts.

3. The correspondence between the major DOD and NASA contractors is quite high. Of the top 25 NASA contractors in fiscal 1966, 16 also were among the top 25 DOD contractors. The other 9 all made the top 100 DOD contractors for the year.

4. The giant firms, however, do not dominate government procurement. The medium size corporations (those with assets in the \$250-999 million range) receive larger shares of defense contracts than either the very large firms (those with assets in excess of \$1 billion) or relatively small firms (those with assets below \$250 million).

5. The firms most heavily dependent on military orders also are the medium-sized companies and not the giants of American industry. Of the companies on the list of the top 100 DOD contractors in 1965, the great majority of those with assets of \$1 billion or more obtained most of their sales from civilian markets. The majority of the smaller firms in the list received the bulk of their sales from military customers.

6. Unlike other markets, competition in high technology government markets relates more often to technical performance than to price. Based on this broad view of competition, NASA reports that the bulk 63 percent of its contracts are let competitively; for the DOD the competitive share came to 50 percent in 1966. However, data on individual competitions are not available.

7. An indirect method of analyzing the degree of competition is to examine the turnover among the dominant firms in a market. Viewed in isolation, the entrenchment of the dominant DOD firms is striking; 21 of the top 25 contractors in 1966 were also in the top 25 a decade earlier. However, the exact same result occurs when the turnover among all American industrial corporations is examined during the same period -- 21 of the top 25 industrial firms in 1966 also were on the list of the top 25 in 1957. This indicates that market concentration is not unique to government purchasing but is characteristic of American industry.

8. Another indirect measure of the intensity of competition is the concentration ratio which indicates the share of a market obtained by a small number of firms. It has been suggested that high seller concentration (and hence possibly limited competition) occurs when the largest eight firms control 70 percent or more of the sales of an industry. An analysis of the 17 major product categories for Air Force procurement in 1966 reveals that only three cases met this requirement for high concentration -- aircraft engines, combat vehicles, and airframes and spares. Large market areas which would not be considered highly concentrated include missile and space systems, weapons, ammunition, electronics equipment, and construction. Less stringent standards of market concentration, of course, indicate more cases of implied lesser competition.

9. On balance, statements so frequently made concerning the large degree of concentration and monopoly in military and related government procurement do not appear to be supported by the data publicly available. Medium sized rather than giant firms receive the largest market shares and substantial competition occurs, at least in large and important segments of these markets.

Appendix Table 1

CONCENTRATION IN U. S. AIR FORCE PROCUREMENT, FISCAL YEAR 1966

<u>Market Category and Company</u>	<u>Value of Contracts Awarded (millions)</u>	<u>Percent</u>	<u>Cumulative Percent</u>
<u>Aircraft Engines</u>			
1. United Aircraft Corp.	\$ 795.0	36.3	
2. General Electric	621.0	28.8	65.2
3. Avco Corp.	301.9	13.8	79.0
4. General Motors Corp.	164.3	7.5	86.5
Other companies	294.6	13.5	100.0
Total	2,184.9	100.0	
<u>Other Aircraft Parts</u>			
1. Bendix Corp.	71.8	6.8	
2. Lear Siegler Inc.	62.8	6.0	12.8
3. United Aircraft Corp.	59.6	5.7	18.4
4. Litton Industries Inc.	55.7	5.3	23.7
Other companies	803.6	76.3	100.0
Total	1,053.6	100.0	
<u>Airframes and Spares</u>			
1. Lockheed Aircraft Corp.	947.9	19.9	
2. McDonnell Corp.	649.8	13.6	33.5
3. Boeing Co.	554.8	11.6	45.2
4. General Dynamics Corp.	503.0	10.6	55.8
Other companies	2,104.6	44.2	100.0
Total	4,760.2	100.0	
<u>Missile and Space Systems</u>			
1. Lockheed Aircraft Corp.	509.7	11.6	
2. American Telephone & Telegraph Corp.	444.1	10.1	21.7
3. Martin Marietta Corp.	363.0	6.0	41.4
4. North American Aviation Inc.	306.1	7.0	28.7
Other companies	2,836.1	65.4	100.0
Total	4,459.0	100.0	

Appendix Table 1 Continued

<u>Market Category and Company</u>	<u>Value of Contracts Awarded (millions)</u>	<u>Percent</u>	<u>Cumulative Percent</u>
<u>Ships</u>			
1. General Dynamics Corp.	\$ 80.3	19.6	
2. General Electric Co.	92.8	6.5	26.0
3. U. S. Atomic Energy Commission	84.5	5.9	31.9
4. Westinghouse Electric Corp.	79.4	5.5	37.5
Other companies	1,099.2	62.5	100.0
Total	1,436.2	100.0	
<u>Combat Vehicles</u>			
1. General Motors Corp.	170.9	28.9	
2. FMC Corp.	89.6	15.2	44.1
3. Chrysler Corp.	86.1	14.6	58.7
4. Bowen McLaughlin	39.8	6.7	65.4
Other companies	203.9	34.6	100.0
Total	590.3	100.0	
<u>Non-combat Vehicles</u>			
1. Kaiser Industries Inc.	357.5	35.8	
2. Ford Motor Co.	89.1	8.9	44.7
3. General Motors Corp.	55.4	5.5	50.2
4. Continental Motors	52.4	5.2	55.5
Other companies	444.8	44.5	100.0
Total	999.2	100.0	
<u>Weapons</u>			
1. General Electric Co.	74.8	14.4	
2. Colt Manufacturing Co.	60.5	11.6	25.9
3. Emerson Electric Manuf. Co.	14.6	2.8	28.7
4. Federal Republic of Germany	12.6	2.4	31.2
Other companies	361.0	68.8	100.0
Total	523.5	100.0	

Appendix Table 1 Continued

<u>Market Category and Company</u>	<u>Value of Contracts Awarded (millions)</u>	<u>Percent</u>	<u>Cumulative Percent</u>
<u>Ammunition</u>			
1. Honeywell Inc.	\$ 155.8	5.4	
2. General Tire & Rubber Corp.	154.6	5.3	10.7
3. Olin Mathieson Chem. Corp.	153.6	5.3	15.9
4. Remington Arms Corp.	139.6	4.8	20.7
Other companies	2,295.8	79.3	100.0
Total	2,899.4	100.0	
<u>Electronics Equipment</u>			
1. Collins Radio Co.	228.6	5.7	
2. Sperry Rand Corp.	181.0	4.5	10.2
3. Intn'l Teleph. & Telegraph	175.7	4.4	14.6
4. Westinghouse Electric Corp.	170.6	4.3	18.9
Other companies	3,239.0	81.1	100.0
Total	3,995.0	100.0	
<u>Petroleum</u>			
1. Standard Oil Co. of New Jersey	207.9	16.2	
2. Royal Dutch Petroleum Co.	106.6	8.3	24.5
3. Socony Mobil Oil Co.	93.2	7.3	31.8
4. Standard Oil Co. of Calif.	83.3	6.5	38.3
Other companies	786.5	61.6	100.0
Total	1,279.4	100.0	
<u>Building Supplies</u>			
1. Kaiser Industries Inc.	58.6	14.2	
2. Joseph Pickards & Sons	19.6	4.8	14.8
3. Dow Chemical Co.	18.4	4.5	19.3
4. Syro Steel Co.	16.3	4.0	27.4
Other companies	298.8	72.6	100.0
Total	411.7	100.0	

Appendix Table 1 Continued

<u>Market Category and Company</u>	<u>Value of Contracts Awarded (millions)</u>	<u>Percent</u>	<u>Cumulative Percent</u>
<u>Production Equipment</u>			
1. Kearney Trecker Corp.	\$11.7	6.5	
2. Avco Corp.	10.7	6.0	12.5
3. General Electric Co.	7.7	4.3	16.8
4. U. S. Steel Corp.	6.9	3.8	20.6
Other companies	142.5	79.4	100.0
Total	179.5	100.0	
<u>Transportation Equipment</u>			
1. General Amer. Transportation	4.1	45.4	
2. General Electric Co.	2.3	25.4	70.7
3. Marlis Industries Inc.	.6	7.0	77.7
4. Mansa Waggon GMBH	.5	5.3	83.0
Other companies	1.5	17.0	100.0
Total	9.1	100.0	
<u>Construction</u>			
1. Raymond-Morrison-Knudsen	547.9	29.5	
2. Morrison Knudsen & Assoc.	35.5	1.9	31.4
3. Kidde Walters Constructors	25.0	1.4	32.8
4. Creighton Ernst & Wallace	22.9	1.2	34.0
Other companies	1,224.7	66.0	100.0
Total	1,856.1	100.0	
<u>Construction Equipment</u>			
1. Clark Equipment Co.	34.1	15.8	
2. International Harvester	21.2	9.8	25.6
3. Chrysler Corp.	19.6	9.1	34.6
4. American Hoist and Derrick Co.	19.9	9.0	43.6
Other companies	122.2	56.4	100.0
Total	217.1	100.0	

Appendix Table 1 Continued

<u>Market Category and Company</u>	<u>Value of Contracts Awarded (millions)</u>	<u>Percent</u>	<u>Cumulative Percent</u>
<u>Materials Handling Equipment</u>			
1. Pettibone Mulliken Corp.	\$ 14.4	13.6	
2. Otis Elevator Co.	9.6	9.1	22.7
3. Hyster Co.	9.2	8.7	31.5
4. Condec Corp.	3.9	3.8	35.2
Other companies	68.2	64.8	100.0
Total	105.3	100.0	
<u>All Other Supplies and Equipment</u>			
1. Delong Corp.	38.5	2.6	
2. Caterpillar Tractor	26.2	1.8	4.4
3. Hupp Corp.	23.9	1.6	6.0
4. General Cable Corp.	20.9	1.4	7.5
Other companies	1,354.2	92.5	100.0
Total	1,463.6	100.0	
<u>Other Fuels and Lubes</u>			
1. Shipping & Coal Co.	25.4	46.8	
2. U. S. Interior Dept.	3.7	5.7	52.5
3. Evan Jones Coal Co.	2.9	5.3	57.8
4. Pittson Clinchfield Coal Sales	2.2	4.1	61.9
Other companies	20.7	38.1	100.0
Total	54.3	100.0	
<u>Photographic Supply and Equipment</u>			
1. Eastman Kodak Co.	42.8	26.0	
2. Kollsman Instrument Corp.	20.0	12.1	38.1
3. McDonnell Corp.	16.4	9.9	48.0
4. Fairchild Camera & Instrument Corp.	7.5	4.8	52.8
Other companies	78.2	47.2	100.0
Total	164.8	100.0	

Appendix Table 1 Continued

<u>Market Category and Company</u>	<u>Value of Contracts Awarded (millions)</u>	<u>Percent</u>	<u>Cumulative Percent</u>
<u>Containers</u>			
1. Goodyear Tire and Rubber Co.	\$ 2.8	39.9	
2. U. S. Rubber Co.	1.7	22.6	62.5
3. ETS Hokin & Galvin Inc.	1.2	16.8	79.3
4. Washington Aluminum Co.	.6	8.9	88.2
Other companies	.8	11.8	100.0
Total	7.2	100.0	
<u>Subsistence</u>			
1. Oscar Mayer & Co.	33.1	3.0	
2. General Foods Corp.	21.8	2.0	5.0
3. Swift & Co.	20.0	1.8	6.8
4. Blue Star Foods Inc.	13.7	1.2	8.0
Other companies	1,013.8	92.0	100.0
Total	1,102.4	100.0	
<u>Medical and Dental Equipment</u>			
1. American Cyanamid Co.	10.3	4.8	
2. American Home Products Corp.	9.7	4.5	9.2
3. Chas. E. Pfizer Co.	9.1	4.2	13.5
4. Sterling Drug Co.	7.9	3.7	17.2
Other companies	178.3	82.8	100.0
Total	215.2	100.0	
<u>Textiles and Clothing</u>			
1. J. P. Stevens Co. Inc.	75.8	5.9	
2. Burlington Industries	36.4	2.8	8.7
3. Prestex Inc.	28.7	2.2	11.0
4. Putman Mills Corp.	28.3	2.2	13.2
	1,117.2	86.8	100.0
Total	1,286.4	100.0	

Appendix Table 1 Continued

<u>Market Category and Company</u>	<u>Value of Contracts Awarded (millions)</u>	<u>Percent</u>	<u>Cumulative Percent</u>
<u>Services</u>			
1. Pan American World Airways Inc.	\$ 170.1	5.6	
2. American Telephone & Telegraph Corp.	153.2	5.0	10.6
3. International Business Machines	114.4	3.8	14.4
4. Defense Facilities Admn.	97.1	3.2	17.6
Other companies	2,506.2	82.4	100.0
Total	<u>3,041.0</u>	<u>100.0</u>	

Source: Computed from data supplied by Data Services Center, Comptroller,
Headquarters U. S. Air Force.